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COMPACT CARS ONLY IN YELLOW SPACES
CURB LANE RIGHT TURNS & BUSES ONLY 4-6:30 P.M.
Amtrak
NEXT LE
NO TURNS ON RED
BIKE ROUT
RESTRICTED RIGHT LANE
AHEAD
CAR - VAN POOL INFO 796 - Pool
Park & Ride NEXT RIGHT

Safety: Who Needs It?

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Swedish Study Shows:

Using Rear Seat Belts Reduces Injuries 28%

The following article was prepared by H. Norin, A. Nilsson-Ehle, E. Saretok, from the Volvo Car Corporation, and C. Tingvall from the Swedish Road Safety Office. The study was presented at the Eighth International Technical Conference on Experimental Safety Vehicles.

In Sweden, more than 25,000 car occupants are killed or injured annually. Slightly more than a fifth of these are rear seat occupants.

When the act requiring compulsory use of front seat belts came into effect in 1975, the use of front seat belts increased extensively. Thanks to this, a large number of people have escaped serious injury.

Although seat belts are installed in the rear seats of 75% of Sweden's car population, they are used by less than 5% of rear seat occupants according to studies carried out by TSV.

Background Data

Each new Volvo car sold in Sweden is covered by a 3 year or a 5 year "warranty" — PVG, a form of built-in motor vehicle damage insurance.

In the event of a road accident, and when the Volvo vehicle is covered by this "warranty" and the repair cost exceeds approximately SKR 4,000 (Krona is worth approximately 18¢) the vehicle is inspected by a Claims Inspector from the PVG Department.

In connection with this inspection, accident data are documented on behalf of the Volvo Traffic Accident Research Department. In this manner, a data bank has been built up covering all of the more serious road accidents which took place in Sweden between 1974-76 and between 1978-79 in which a Volvo 140 or 240 was involved.

The analysis material covers a total of about 8,000 accidents. In those cases where there was a rear seat passenger — whether the passenger was injured or not — the accident has been selected for further study.

The accidents selected in this manner involve 2,265 rear seat occupants. Of these, 141 were belted 1,684 were unbelted, while in the case of 440 rear seat occupants, use of the seat belt was unknown. The latter group was then excluded from the analysis. These missing data have been checked and it was found that they had no effect on the analysis result.

Results of the Analysis

The following is the result of studies of seat belt use by rear seat occupants. The way in which seat belt use is influenced by various traffic environments is also studied.

Seat belt use by rear seat occupants in this accident material is 7.7%. This is somewhat higher than the TSV reports covering all makes of cars in Sweden.

For the outer rear positions (left and right sides), the frequency of use is 9.4%. For the middle position, it is 3.4%.

Table 1 shows that seat belt use by rear seat occupants of both sexes is relatively comparable. The table also shows that the frequency of use within the 1-14 years age group is lower than it is for the two other groups. For the outer rear seat positions there are three point seat belts, of static or inertia reel type. In the middle rear position there is a static lap belt.

The type of belt and the type of journey are two factors which have an influence on seat belt use. Therefore, a division was made between vehicles with and without rear seat belts of inertia type. In addition, a division was made between types of journey based on the road environment where the accident took place.

The frequency of use is approximately twice as high as in vehicles with static three point belts.

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The table also shows that seat belt use by rear seat occupants is decidedly influenced by the type of road environment in which the accident occurred. The various road environments probably indicate differences in the type of journey, such as length of journey, etc. Marked differences can thus be observed in the frequency of seat belt use.

For example, rear seat occupants of vehicles without inertia reel belts traveling on a main, village and suburban road have a frequency of use of only 4%. Occupants of vehicles with inertia reel belts, in accidents occurring on motorway and freeway, were using their rear seat belts in approximately 28% of the cases.

Bearing in mind the higher speeds on highways and motorways it can be presumed that the accidents are more serious on these types of roads than they are in town traffic.

Since rear seat occupants show a greater tendency to wear their seat belts when travelling on motorways and main roads, a comparison between accidents with belted occupants versus unbelted occupants can be expected to show a tendency to include more serious accidents for the belted occupants (higher speeds = belted occupants).

Considering the situation, it is not probable that the estimated effects of the rear seat belts have been exaggerated.

Accident Survey Results

An investigation of the effect of belt use for rear seat occupants has been carried out by Volvo Car Corporation and the Analysis Department of the Swedish Road Safety Office. (TSV).

The report is based on approximately 2,000 relatively serious accidents in Sweden in which a Volvo 140 or 240 has been involved and in which there was at least one rear seat occupant in the Volvo Vehicle.

From the results we can see that seat belt use by rear seat occupants in this accident material is 7.7%. The seat belt use by rear seat occupants is decidedly influenced by the type of journey, and also by type of seat belt available in the car. Rear seat occupants differ from front seat occupants in being largely children. A clear difference is apparent in injury frequency between children and adults. If this difference in age grouping and injury frequency is taken into account, the analysis indicates that the injury risk is approximately the same for all seats in the car. Furthermore there is a clearly apparent difference in injury percentages for belted and unbelted occupants, both children and adults. The injury-reducing effect of seat belt use in the rear seat is about 28% for adult occupants.

Table 1.

Belt use by age, sex and position in rear seat.

Age	Outer positions		Middle positions	
	Male	Female	Male	Female
1-14	6.4%	7.6%	2.5%	2.2%
15-56	11.2%	10.4%	5.7%	5.1%
57 and over	14.3%	9.6%	—	—

Table 2.

Belt use by rear seat occupants with regard to type of belt and road environment.

	Static belt	Inertia reel belt
Motor and Freeway	15.8%	27.8%
Highway	8.0%	16.8%
Village and Suburban Roads	4.0%	7.0%

Type of Accident and Degree of Severity

To clarify the differences in accidents in which the rear seat occupants were belted or unbelted and in which the degree of severity and type of accident differ, these accident groups have been compared.

Table 3 shows that the number of accidents in both groups is approximately the same. The small variations that do exist are not expected to influence the analysis of seat belt effect.

(Vehicle Deformation Index-VDI is a method of determining vehicle deformation as a result of an accident. The figure 20 represents a 20% deformation of half the vehicle's length.)

Due to the relatively low number of cases in which rear seat occupants were wearing seat belts it has not been considered worthwhile to breakdown the accident statistics further.

For the most common type of accidents, frontal collisions, the cases can be divided into two groups: Those resulting in slight deformation of the vehicle front, and large deformation of the vehicle front.

On basis of the figures shown in **Table 3** there is no indication that accidents, in which the rear seat occupants were belted, differ in either type of severity, from those in which rear seat occupants were not belted.

Risk of Injury: Rear Seat Versus Front Seat

It is generally supposed that in case of an accident the rear seat of a car is a relatively safe place in which to travel and that use of seat belts by rear seat occupants is not very necessary.

Many people also prefer to travel in the rear seat instead of sitting in the front and being legally compelled to use the seat belt.

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Abbreviated Injury Scale (AIS) is a method of describing injuries in code form. The severity of the injury can vary from 1 (slight injuries) to 6 (fatal injuries).

The front seat occupant numbers have been taken from the 1974 accident statistics, that is to say before the compulsory use of seat belts for front seat occupants came into force in January 1975. The reason is that this provides an accident group

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Table 3.

Distribution of various types of accident for vehicles with belted and unbelted occupants.

Type of accident	Rear seat passengers	
	belted	unbelted
Frontal collision slight deformation VD1 <20	27%	29%
larger deformation VD1 ≥20	13%	13%
Side collision	16%	18%
Rear end collision	8%	7%
Rollover	10%	9%
Multiple accident	15%	13%
Other types	11%	11%
Total	100% 141 cases	100% 1684 cases

Table 4.

Injury frequency of unbelted occupants in front seats and in rear seats.

	No. of occupants	AIS 1-6	AIS 3-6
Drivers	1,284	35.6%	3.0%
Front seat passengers	429	40.8%	3.7%
Rear seat passengers	1,684	32.6%	2.6%

Table 5.

Division by age groups in front and rear seat.

Age	Driver	Front seat passenger	Rear seat passenger
1-14	—	4%	40%
15-56	87%	82%	51%
57 and over	13%	14%	9%

Table 6.

Injury frequency of unbelted rear seat occupants divided into age groups.

Age	No. of occupants	AIS 1-6	AIS 3-6
1-14	658	27.4%	2.3%
15-56	835	35.1%	2.9%
57 and over	139	47.5%	3.6%

Unbelted rear seat passengers can be thrown into the front seat and injure the driver and other front seat passengers.

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which is more comparable with accidents in which the vehicle had rear seat occupants.

Table 4 shows that the accident frequency for rear seat passengers is lower than for front seat passengers and, in some cases, also for the driver. This would seem to confirm the opinion mentioned in the introduction that the rear seat is a safer place in which to travel than the front seat. However, the risk of injury is greatly dependent on the age of the occupant. The age spread also varies considerably between the various places in the vehicle.

Study of **Table 5** will clarify this situation. This table shows division by age of unbelted occupants.

The injury frequency for occupants between the ages of 15 and 56 is relatively stable. Therefore, occupants in this age bracket have been concentrated to one group. This group is compared with younger occupants (children) and older occupants.

Table 5 shows that rear seat occupants differ from front seat occupants in being largely children. What are the injury frequencies for occupants in these respective age groups? Let us take a closer look at rear seat occupants that have not used seat belts since this is a large group with all ages represented.

Injury Frequency

A clear difference is apparent in injury frequency between the three age groups concerning both the total injury frequency and the serious to fatal group of injuries. This difference in age grouping and injury frequency must be taken into account when appraising the risk of being injured in the different places in a car. To reduce the risk of incorrect appraisal, the child group and the oldest occupants group were excluded from the statistical input for **Table 4**. After having made this adjustment, new injury frequencies for each respective position appear as shown in **Table 6**.

Table 7 shows that the frequency of injury of drivers, front seat passengers and rear seat passengers is approximately the same in the age group 15-56 years. The slightly higher percentage of minor injuries to front seat passengers is probably because this group includes a slightly higher percentage of females.

Table 7.

Injury frequency of unbelted adults between 15-56 years of age in front and rear seats.

	No. of occupants	AIS 1-6	AIS 3-6
Drivers	1,118	35.2%	2.7%
Front seat passengers	368	40.6%	2.5%
Rear seat passengers	835	35.1%	2.9%

The analysis indicates that the risk of being injured, concerning both light injuries and serious to fatal injuries, does not lessen if an unbelted passenger moves from the front to the rear seat.

Seat Belt Effect for Rear Seat Occupants

The amount of material in the analysis permits a comparison between the number of rear seat occupants wearing seat belts and not wearing seat belts. To make this comparison worthwhile, the rear seat occupants have been divided into two groups: children and adults.

In spite of the partly limited documentation, there is a clearly apparent difference in injury percentages for belted and unbelted occupants, both children and adults. The effect of the seat belt is approximately the same in the front seat as it is in the rear seat. (1,2) On the basis of previous studies it is known that the effect is greater in more serious accidents. The material studied for rear seat occupants also indicates this fact.

The most serious injury among the belted children was an uncomplicated fracture of the right wrist (AIS 2). Serious injuries were also rare among the belted adults in the group.

The use of seat belts primarily reduces head injuries. In the case of children, the total frequency of head injuries is reduced from 17% (112 of 658) to 3% (1 of 38). Among unbelted children, head injuries are the most common type of head injury.

For adult occupants, the equivalent reduction in frequency is from 17% (164 of 974) to 10% (10 of 98) if the seat belt is used. No serious head injuries were found in either adults or children wearing seat belts. ■

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